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Inventory of Fishers in the Sub-boreal Forests of North-Central British Columbia Year II (1997/98): Capture and Radiotelemetry Monitoring

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Abstract

We monitored 13 radio-collared fishers between 4 May 1997 and 19 March 1998 as part of the second year of a 5-year project examining the ecology of fishers in sub-boreal landscapes of north-central British Columbia. The objectives of the second phase were to document the home ranges, movements, and habitat use of fishers.

We estimated annual home ranges for 7 fishers and monitored the movements of 3 juveniles. We calculated annual home ranges from the 90% isopleth of the utilisation distribution using the adaptive kernel method. The home ranges of fishers varied between 23.4 km^2 and 183.9 km^2 and appeared to be intrasexually exclusive. The mean home range size for females was smaller than that of the one male that we monitored ($\bar{x}$ female = 50.6 km^2, SE = 20.7, n = 6; male = 183.9 km^2). The annual home ranges that we observed were larger than that reported elsewhere, likely because of differences in the distribution of resources between our study area and other regions.

We assigned 325 locations collected between 18 November 1996 and 19 March 1998 to one of six precision categories. We used these precision categories to determine the suitability of each location for habitat analyses at four spatial scales. In total, we collected 9 locations suitable for element scale analyses, 105 locations for patch scale analyses, 187 locations for stand scale analyses, and 325 locations for landscape (home range) scale analyses.

We recorded 5 radio-collared female fishers using natal and maternal dens during April-May 1997. We located natal dens for 5 female fishers and documented the use of 2 maternal dens; however, we were unable to assess productivity of the females. We recorded female fishers denning exclusively in large diameter, declining black cottonwood or balsam poplar trees. The unique decay characteristics of these large diameter trees likely makes them suitable elements for rearing kits.

We recorded the composition of the overstory at 190 locations during aerial telemetry flights. Fishers used stands composed primarily of hybrid spruce most frequently (31.6% of locations) as well as regenerating clearcuts or burns (30.0% of locations). This result is not unexpected as both of these stand types comprise substantial proportions of our study area and use of these types may not constitute any selectivity by fishers. Conclusions regarding habitat selectivity should only be drawn after the appropriate use versus availability analyses have been performed.

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1.0 INTRODUCTION

The fisher *(Martes pennanti)* is a medium-sized member of the Mustelidae (weasel) family that inhabits much of the lowland forested area that dominates the plateau of north-central British Columbia. Although much of this landscape supported viable populations of fishers in the past, populations have declined recently (Banci 1989). Several factors may have contributed to this decline.

Fishers are considered to be habitat specialists, fulfilling most of their life requirements in forested habitats (Powell 1982, Weir 1995). Evidence from studies of fishers in western coniferous forests indicates that fishers require late-successional seral stages or elements for foraging, resting, and whelping (Jones 1991, Weir 1995). Because of this association with late-successional forests, forest harvesting activities that focus on late-successional forests can have detrimental effects on fisher populations by altering and degrading the abundance and distribution of the resources that they require.

Aside from the potential effects of forest harvesting, fisher populations are also negatively affected by humans through fur harvesting activities. Fishers are identified as furbearers under the British Columbia Wildlife Act and are trapped for their pelts, despite their populations being considered "vulnerable" (blue-list) by the provincial Conservation Data Centre. Fishers are also classified by the Wildlife Branch of the Ministry of Environment, Lands and Parks as Class 2 furbearers because they are susceptible to overharvest, their populations occur at low densities, and home ranges of individual fishers can span more than one trapline (Banci 1989). Although fisher pelts are valuable relative to other furbearing mammals, the majority of the harvest of fishers in British Columbia is the result of incidental captures in traps set for martens *(Martes americana)*.

The broad goal of this study is to collect information to facilitate management of fishers and their habitat in the industrial landscapes of northern British Columbia. The objectives for the second year of this project were to continue to monitor the home ranges, movements, and habitat use of fishers in a representative forest landscape of sub-boreal forests in north-central British Columbia. Specific objectives were to identify natal and maternal dens of fishers, examine the productivity of female fishers, assess dispersal movements of juvenile fishers, identify resting sites, and capture and collar new individuals and fishers with malfunctioned radiocollars.

Funding for this project was provided by the Operational Inventory Program Portfolio of Forest Renewal British Columbia (Project # OP96-

220) and the Peace/Williston Fish and Wildlife Compensation Program, a joint venture between BC Hydro and the British Columbia Ministry of Environment, Lands and Parks. Partners in this inventory program were the Peace/Williston Fish and Wildlife Compensation Program, the BC Ministry of Environment, Lands and Parks, Finlay Forest Industries Ltd., the Slocan Group, and the British Columbia Trapper's Association. The project was conducted cooperatively with the Northern Wolverine Study (Forest Renewal British Columbia Project # OP97-078), whose personnel assisted in the collection of trapping data. F. Corbould administered project funds, assisted in the field, and provided reviews of drafts of this document. A. Bowser, H. Davis, and V. Hawkes helped monitor traps, radio-collar fishers and wolverines, and perform radiotelemetry. R. Critchton scaled and measured the natal and maternal den trees. Members of the Peace/Williston Fish and Wildlife Compensation Program Technical Committee provided helpful comments on earlier drafts of this report.

2.0 STUDY AREA

The study area covers approximately 2,160 km^2 and is centred 70 km north-west of Mackenzie, British Columbia (Fig. 1). The entire area is within the Peace River drainage. All watersheds within the study area drain into the Williston Reservoir. The major watersheds in which the inventory is occurring are the Manson, Omineca, and Mesilinka Rivers. The study area is bounded by Williston Reservoir to the east, Nation River to the south, the Wolverine and Swannell Ranges to the west, and the bend in the Mesilinka River (south of Carina Lake) and Mica Creek to the north.

The study area is located entirely within the Mackenzie Forest District of the Prince George Forest Region and lies within the Sub-Boreal Interior ecoprovince, Omineca Mountains ecoregion, and Parsnip Trench, Southern Omineca Mountains, and Manson Plateau ecosections (Demarchi 1995). The boundary of the study area is defined by the extent of the Sub-Boreal Spruce (SBS) biogeoclimatic zone that occurs in this region. The topography of the study area is characterised by a gently rolling plateau rising from the Rocky Mountain Trench (Williston Reservoir) in the east to the slopes of the Wolverine and Swannell Ranges in the west. The plateau is drained by a series of small creeks with poorly developed or non-existent floodplains. Floodplains with extensive riparian zones exist on only three major rivers: the Manson, Omineca, and Mesilinka Rivers.

The study area is comprised of two subzones of the SBS. At elevations below 800 m, the moist cool subzone (SBSmk) of the SBS occurs, while

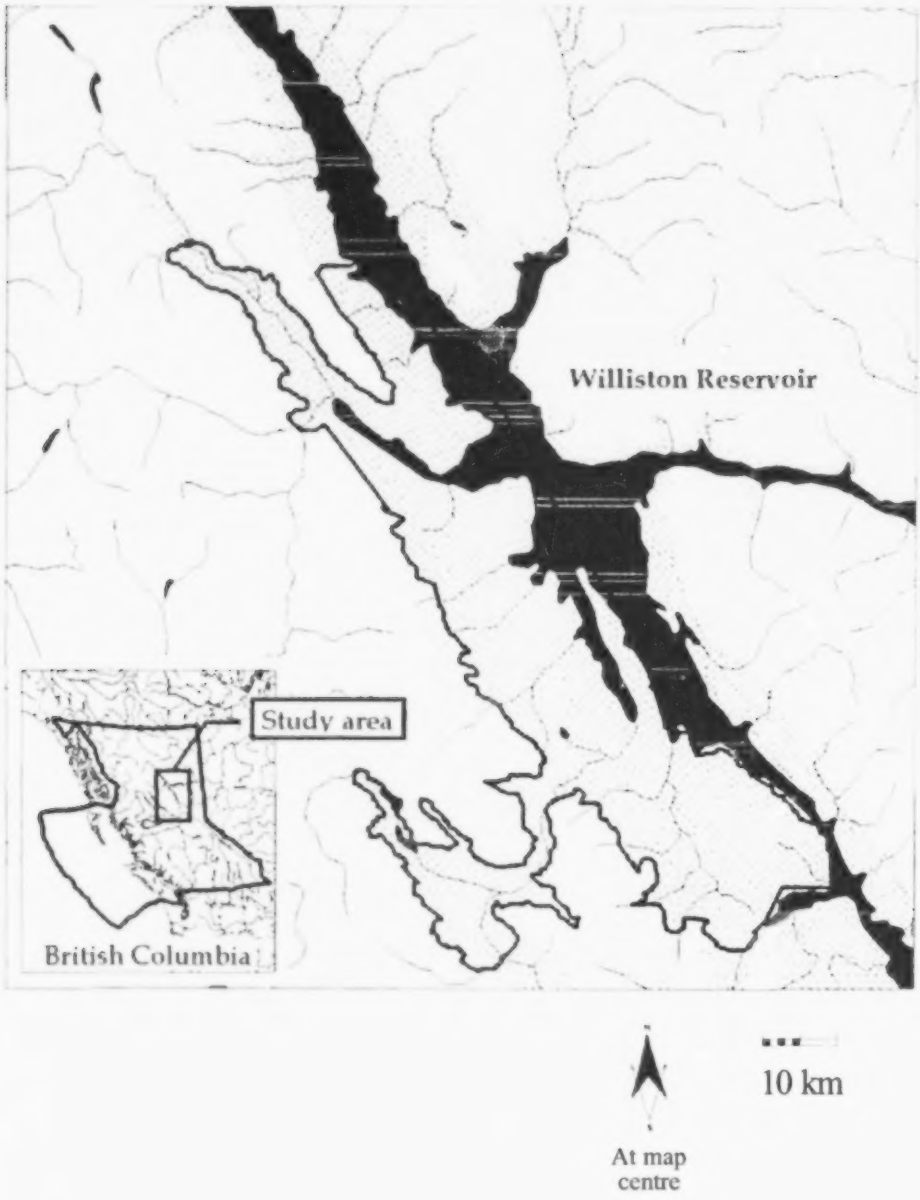

Figure 1. Location of the study area and biogeoclimatic subzones. The study area is comprised entirely of the SBSmk and SBSwk subzones (hatched area). The solid line is the study area boundary.

between 800 and 1100 m, the wet cool subzone (SBSwk) occurs (British Columbia Ministry of Forests 1993). The SBSmk comprises the majority of the study area, covering approximately 80% of the area. Annual precipitation in the SBSmk is 690 mm and 905 mm in the SBSwk (British Columbia Ministry of Forests 1993). Snowfall in the SBSmk is 335 cm/year and 1075 cm/year in the SBSwk (British Columbia Ministry of Forests 1993). Snow cover in the study area generally lasts from November until April.

Forests in the SBSmk are dominated by hybrid spruce *(Picea glauca x engelmannii),* lodgepole pine *(Pinus contorta),* black spruce *(Picea mariana),* and subalpine fir *(Abies lasiocarpa),* with deciduous components of trembling aspen *(Populus tremuloides)* and paper birch *(Betula papyrifera).* Black cottonwoods *(Populus balsamifera* spp. *trichocarpa)* occur as a minor element in riparian-type ecosystems and occasionally in other areas with sub-hygric or wetter ecological moisture regimes. The composition of forests in the SBSwk is similar, with hybrid spruce and subalpine fir being more dominant.

Disturbances in the SBSmk and SBSwk follow a typical pattern. The principal natural disturbance factors in these ecosystems are fire and insect outbreaks (British Columbia Ministry of Forests 1993). Young forest stages are comprised primarily of lodgepole pine, while later successional stands are dominated by spruce and subalpine fir. The SBSmk has a natural disturbance regime of frequent, large-scale burns occurring about every 125 years, while the ecosystems in the SBSwk portion of the study area are exposed to moderate-sized burns with a fire cycle of about 200 years (British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands and Parks 1995). With the flooding of the Williston Reservoir in 1968-72 (Hirst 1991), many of the valley bottom riparian forests in the area were submerged, mostly in the lower Omineca, Manson, and Parsnip Rivers. Forest harvesting, primarily of mature and late-successional stands, has occurred throughout the study area over the past 25 years. Forest harvesting and natural disturbances have resulted in a mosaic of seral stages and stand types throughout the study area.

The study area encompasses five registered fur traplines. Traplines in the northern portion of the study area include 738T009, which is located primarily on the Mesilinka River, and 738T010, which occupies the Chunamon Creek/Raspberry Harbour area. Trapline 729T005 runs from km 155 on the Finlay Forest Service Road south beyond the Manson River. Trapline 728T007 occurs on the Manson River drainage west of the Wolverine Range and 729T004 occupies the Blackwater Creek area.

3.0 METHODS

3.1 Trapping

We attempted to capture fishers to radio-collar new animals and replace malfunctioned and expiring radiocollars on previously-collared individuals. We used four types of live-trap sets to capture fishers: barrel, log-cabin, Havahart collapsible, and Havahart permanent. We set primarily Havahart permanent traps (Model 1081), which were wire-mesh sets approximately 24.5 x 31 x 81 cm. Havahart collapsible traps (Model 1089) were similar in dimensions to the permanent type, but collapsed by the back door folding out and the sides of the trap folding inward. We also set and monitored several log-cabin and barrel traps that were intended primarily for wolverines *(Gulo gulo)*. The log-cabin sets were made of intermeshing logs, with a trigger mechanism that released a log door when a bait was pulled from inside the trap (Krebs 1993). Barrel traps consisted of a 45 gallon drum with a sliding door cut into one end (Banci 1987), similar in design to culvert traps used to capture bears. Log-cabin traps were immobile, while barrel and Havahart traps were portable.

We set traps to ensure that animals remained dry, insulated, and had a supply of food while trapped. We placed the Havahart traps on beds of hybrid spruce or subalpine fir boughs and covered the top, sides, and bottom of the traps with disassembled waterproof cardboard boxes (tree planting boxes). Traps were lined with straw and covered with more boughs so that snow or wind did not penetrate the trap. We also added straw to the interior of barrel and log-cabin traps. We usually baited each Havahart trap with approximately 500 g of moose meat, but occasionally used grouse and duck carcasses for bait. Log-cabin and barrel traps were baited with pieces of moose carcass (1.5 - 3 kg).

We took several actions to enhance the efficacy of the traps. At each trap site, nearby vegetation was scented with a combination of commercial fisher, marten, and beaver lure, and skunk oil. Scent was re-applied every 3-5 days. Prior to setting the trap for the first time, the pan, cable, and door of each trap were lubricated with petroleum jelly and tested to ensure proper trap performance.

We checked traps daily and assessed the functioning of each trap every 2-3 days. The status of each trap was recorded for each night (i.e., one trap night) from one of the following descriptive categories: species captured, empty, blocked, tripped, escape, or no bait. "Empty" was recorded for those trap nights during which trap function was normal but no animals were caught. "Blocked" was recorded for trap nights during which the trigger, pan, or door was interfered with in some

manner and thus did not function properly. "Tripped" traps occurred when the trigger, pan, and door functioned properly but the animal was not captured. Tripped traps were often caused when either ermine *(Mustela erminea)* tripped the pan and escaped through the side of the traps or wolverines or bears *(Ursus* spp.) disturbed the traps. "Escapes" occurred when animals tripped the trap, but managed to forcibly break out of the trap. "No bait" traps occurred when the bait was stolen from the trap, but all components of the trap were working properly. We considered trap nights during which the trap malfunctioned (block, trip, escape, no bait) as partial trap nights (0.5 trap night).

When we captured non-target species in the traps, we fed them a small amount of strawberry jam (to reduce likelihood of hypoglycaemia) and released them immediately. We closed and removed traps at locations where martens were captured on more than 5 consecutive nights.

We recorded maximum and minimum temperatures, as well as snow depths, on a daily basis at various locations throughout the study area. Temperature stations were located at 5 sites: Munro Creek, Manson River, Centennial Creek, Omineca River, and Mesilinka Camp. Thermometers and snow stations were placed under normal forest canopy at least 10 m from the forest edge. We calculated mean daily temperatures and mean snow depths using data collected from each of these stations.

We calculated various measures of capture rates for different species and trap types. We calculated the number of captures per 100 trap nights for fishers, wolverines, and non-target species. We used chi-square goodness-of-fit tests to assess the frequency of capture among the following temperature ranges: <-10 C°, -10 to 0 C°, 0 to 10 C°, and >10 C°. We used chi-square tests to examine the frequency of malfunctions among the different trap types. We set the acceptable Type I error rate to 0.05.

3.2 Immobilisation and Handling

Prior to immobilisation, we estimated the body weight of each fisher to ensure that animals were administered appropriate dosages of anaesthetic. We used a handling cone to restrain the animal and administered drugs with a hand-held syringe for fishers captured in Havahart traps. We injected anaesthetic to fishers in log-cabin traps using a jab-stick.

Fishers were immobilised using a 1:1 mixture of tiletamine:zolazepam (Telazol). We attempted to administer Telazol at 8 mg/kg for untagged fishers and 5 mg/kg for animals that required limited handling (e.g., replacing radiocollars). Because of the dramatic decreases in body

temperature that we observed during immobilisations in the first year of our study (Weir 1997), we placed the immobilised fishers in a sternal position over warm hot-water bottles.

We measured and monitored fishers while they were immobilised (Appendix 1). Sex, body weight, and cranial and skeletal measurements were documented. Each fisher was fitted with a radiocollar (either Holohil M-2 or Telonics MOD-080) and tattooed in the groin area with an individual identification number. We also collected hair samples from each fisher. We classed most fishers as adults or juvenile by palpating the saggital crest and examining the level of tooth wear (Powell 1982). For healthy fishers that were difficult to age using this technique, we removed a premolar 1 tooth for cementum annuli analysis (Strickland *et al.* 1982). Photographs were taken of the head, dorsal, and ventral regions. Respiration and cardiac rate, body temperature, and capillary refill time were also recorded at regular intervals while the fishers were immobilised.

We placed each fisher back in the live trap wrapped in a blanket to recover from anaesthesia and to reduce the likelihood of hypothermia. We released the fishers from cages when they were fully recovered from the effects of the anaesthetic.

3.3 Radiotelemetry Monitoring

We located fishers using standard ground and aerial telemetry procedures (Weir 1995). Fishers were located from the air using Cessna 182 aircraft with two bi-directional H-antennae mounted on the wing struts. For each aerial telemetry location, we recorded the coordinates, time, site characteristics, overstory composition, and estimated precision of the location (Appendix 2). From the ground, we recorded directional bearings from permanent ground stations to fishers using a three-element, collapsible Yagi antennae (Appendix 3). We estimated locations and 95% error polygons from ground telemetry using Locate II software (Nams 1991). We estimated the precision of each location subjectively for aerial locations and used 95% error polygons for ground locations. We then classified each location into one of six precision categories: ± <1 m, ± 1-30 m, ± 31-50 m, ± 51-100 m, ± 101-250 m, and ± >250 m. We assigned capture locations to the least precise category because of the potential bias of this data.

We located fishers once per week from the air and whenever possible from the ground. Coordinates from aerial locations were initially estimated using an on-board global positioning system (GPS). Coordinates were collected as latitude and longitude with a GPS unit and plotted on 1:20,000 forest cover maps as Universal Transverse Mercator (UTM) coordinates. We converted latitude and longitude

coordinates into UTM coordinates for analyses using UTM conversion software (Geological Survey of Canada 1988). Aerial locations were error-checked with 1:15,000 or 1:40,0000 air photographs. All ground telemetry work used UTM coordinates from 1:20,000 forest cover maps. All locations were recorded using North American Datum 1927.

We classified each location into one of three seasons for future home range and habitat use analysis. We defined the seasons as follows: winter: 15 November to 31 March; summer (including rearing): 1 April to 15 August; and autumn: 16 August to 14 November.

3.4 Home Range and Movements

We estimated the size and location of the home range of each resident fisher using two estimators. To allow comparison with other studies, we calculated home ranges using the 95% minimum convex polygon (MCP; Mohr 1947) method for fishers with at least 15 locations. For fishers with more than 20 locations, we also estimated home ranges using the 90% isopleth of the utilisation distribution (UD) generated from the adaptive kernel method (Worton 1989). We calculated the core area of each home range using the 50% isopleth of the same distribution. For fishers with less than 15 locations, we used the 100% MCP method to calculate the total area over which we recorded locations. We used CALHOME (Kie *et al.* 1994) home range software for each of these calculations.

We used several measures to assess dispersal of the juvenile fishers that we radio-collared. The straight-line distance between successive locations was determined to estimate the minimum movements made while transient. We measured the distance between the capture location of each juvenile and the centre of their new home range to determine the net dispersal distance. We also calculated the total area over which the juveniles travelled using the 100% MCP.

3.5 Habitat Use

There are four spatial scales at which habitat use patterns may be analysed. These scales are nested and range from fine (element) scale to coarse (landscape) scale. We considered each location for its suitability for inclusion in habitat analyses at 4 different spatial scales: element, patch, stand, and landscape. *Elements* are single structural features of habitat such as a piece of coarse woody debris or a large tree. *Patches* consist of assemblages of habitat elements and range in area up to 0.3 hectares. *Stands* are composed of patches and vary from 15 ha to hundreds of hectares. The *landscape* is composed of stands and is

defined as the boundary of our study area (i.e., Sub-Boreal Spruce biogeoclimatic zone).

Each telemetry location is suitable for use in habitat analyses at different spatial scales, depending on its level of precision. Precise locations are suitable for inclusion in analyses at fine spatial scales (e.g., element scale), while less precise locations are only suitable for coarser scale analyses (e.g., landscape scale). For example, the location of a fisher at a resting site could be used as data for habitat analysis at all four spatial scales. Because we know the element it was using, we also know which patch it was using, along with which stand and point in the landscape. However, with less precise locations, such as a ground telemetry location with an error polygon of 1.5 ha, we could only identify which stand and point in the landscape was used by the fisher. Thus, more precise locations are appropriate for habitat analyses at the finest scale up to the coarsest scale, while imprecise locations preclude use for analyses at all but the coarsest scales. We classified each location for its suitability for habitat analyses to the following categories based upon its precision: element, patch, stand, and landscape (home range) (Table 1).

During radiotelemetry monitoring, we limited the collection of complete habitat data to the element spatial scale (i.e., structural elements used for rearing young or resting). We did not collect complete habitat information at the patch, stand, or landscape scale. However, during aerial telemetry flights, we did classify the stand based upon the dominant species of the overstory. Each stand that was used by fishers was classified into one of the following categories: black cottonwood, trembling aspen, other deciduous (paper birch, willow *[Salix* spp.], or alder *[Alnus* spp.]), hybrid spruce, black spruce, lodgepole pine, subalpine fir, regenerating clearcuts or burns (5 - 30 years old), and open or otherwise recently disturbed areas.

At the element scale, we collected specific information about the elements used by fishers. We classified the use of each element into three types: natal den, maternal den, and resting site. Natal dens were those structures used by female fishers for whelping. Maternal dens were those structures used in weeks following abandonment of the natal den by the female and kits (i.e., second rearing den). Resting sites were elements that were used for temporary resting by female fishers outside the rearing season and male fishers through all seasons.

We measured several structural features of each element that was used by radio-collared fishers. We recorded the species of tree, diameter-at-breast-height (dbh), and height and type of element used. For natal and maternal dens, we also measured the diameter at den height and the

Table 1. Determination of the suitability of locations for habitat analyses at different spatial scales, ✪ denotes scale for which the location is appropriate for habitat analysis.

Precision of location	Error area	Spatial scale			
		Element	Patch	Stand	Landscape
±<1 m	none	✪	✪	✪	✪
± 1-30 m	< 0.3 ha		✪	✪	✪
± 31-50 m	0.3 - 0.8 ha			✪	✪
± 51-100 m	0.8 - 3.0 ha			✪	✪
± 101-250 m	3.0 -19.6 ha				✪
±>250 m	> 19.6 ha				✪

dimensions of the den entrance and chamber. Chamber width and depth were measured just below the rim of the den entrance, while the chamber height was measured as the distance between the base of the cavity and the rim of the den entrance. We compared the aspect of the den entrances to a uniform distribution using Rayleigh's test (Zar 1984:442).

3.6 Reproduction

We attempted to locate and monitor female fishers that gave birth to kits during the rearing season (April - June). We considered females to have whelped when we repeatedly located them using the same structural element over several weeks *(sensu* Paragi 1990, Powell *et al.* 1997). We monitored females with kits for periods of up to 10 hours on several occasions to determine den attentiveness. We also attempted to determine the number of kits that each female reared by scaling each maternal den tree and searching the den chamber for kits.

4.0 RESULTS

4.1 Captures

We monitored livetrap sets for 3003.5 trap nights at 114 locations from 4 September 1997 to 19 March 1998[1]. Collapsible Havahart traps were used for 983.5 trap nights, permanent Havahart traps for 895.0 trap nights, log-cabin traps for 1095.0 trap nights, and barrel traps for 30.0

[1] The capture data reported does not include all of the captures during the 1997-98 fiscal year. Because of time lines for the production of this report, 5 captures of fishers between 20 and 25 March are not included in this report.

trap nights. Mean daily temperatures ranged between 15 C° and -31 C°, while mean total snow accumulation reached 50 cm (Fig. 2).

We captured animals on 326 occasions at 82 traps (Table 2). We captured 9 fishers at 10 different traps (4 permanent Havahart, 3 collapsible Havahart, and 3 log-cabin traps) throughout our study area. Wolverines were captured 7 times at 6 log-cabin traps. We caught martens 290 times at 75 trap sites (128 captures in collapsible Havahart, 127 captures in permanent Havahart, and 35 in log-cabin traps). We also trapped minks *(Mustela vison)* on 4 occasions, gray jays *(Periosoreus canadensis)* twice, 9 red squirrels *(Tamiasciurus hudsonicus)*, and a northern flying squirrel *(Glaucomys sabrinus)*.

We recorded an overall capture rate of 0.43 fishers per 100 trap nights. Capture rates ranged from O fishers per 100 trap nights in January to 1.21 fishers per 100 trap nights in March (Fig. 3). We recorded the most captures during March, when we caught 4 fishers between 11 and 16 March. We did not detect any effect of mean daily temperature on the frequency of capture ($x^2 = 2.68$, df = 3, P = 0.44).

We allocated special effort to recollaring fishers that were radio-collared during the 1996/97 trapping season. We placed 5 to 15 traps throughout the home ranges of each of 7 fishers. Although we had between 136.5 and 658.5 trap nights in each of the home ranges, we recaptured only F01, F02, F04, and F07 (Table 3). We recorded repeated captures of two fishers during the 1997/98 trapping season: F01 (Beau) was recaptured 2 times after his first capture, while F02 (Patches) was caught once after being recollared.

4.2 Trap Malfunctions

We recorded 88 traps malfunctioning 281 times (Table 4). Havahart collapsible traps were blocked 12 times, while permanent Havahart traps were blocked 13 times. Collapsible traps were tripped 69 times and permanent traps were tripped on 70 occasions. Log-cabin traps accounted for 84 malfunctions. Wolverines were likely responsible for the 4 escapes from Havahart traps that we recorded. The rate of malfunction was significantly different from expected for each trap type, based upon the number of trap nights that each type of trap was set ($x^2 = 8.77$, df = 3, P = 0.03). Collapsible Havahart traps malfunctioned more frequently than expected (Bonferroni-adjusted Z-test, SE = 0.058, $P < 0.001$), while log-cabin traps malfunctioned less frequently than expected (Bonferroni-adjusted Z-test, SE = 0.062, $P < 0.001$). The frequency at which permanent Havahart and barrel traps malfunctioned was not significantly different than expected.

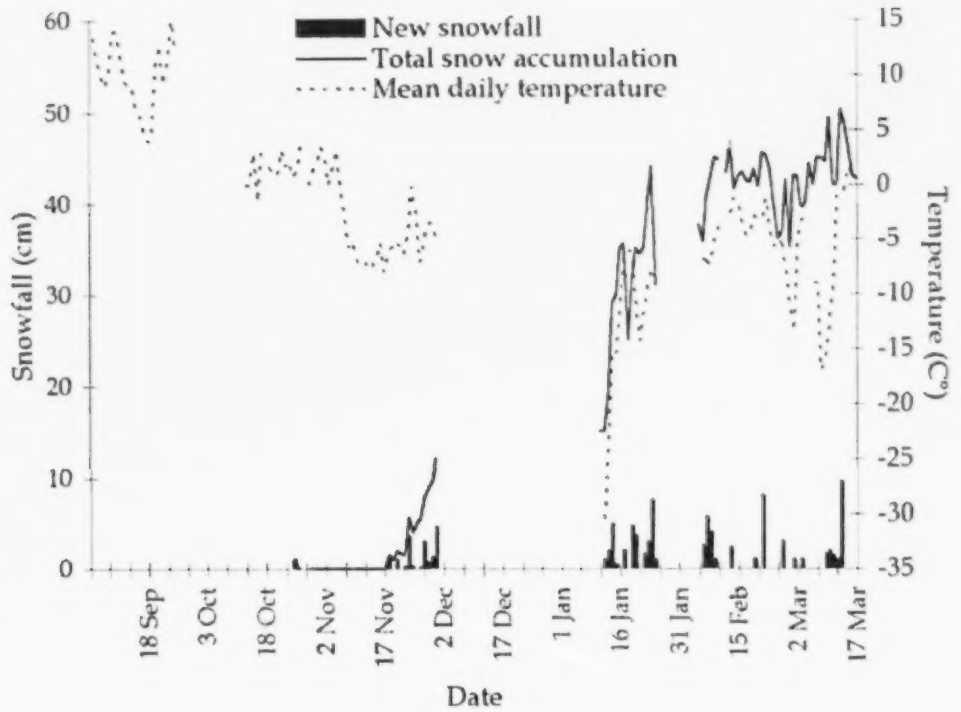

Figure 2. Mean daily temperature and snowfall recorded between 4 September 1997 and 19 March 1998, Williston Fisher Inventory Project. Gaps in lines are from periods during which data was not collected.

Table 2. Frequency of capture of each species by trap type from 4 September 1997 to 19 March 1998, Williston Fisher Inventory Project.

Species	Havahart collapsible	Havahart permanent	Log-cabin	Barrel	Total
Fisher	4	4	5	0	13
Wolverine	0	0	7	0	7
Marten	128	127	35	0	290
Mink	4	0	0	0	4
Squirrel[a]	5	4	1	0	10
Gray jay	2	0	0	0	2
Total	143	135	48	0	326

a Includes red squirrels and northern flying squirrels.

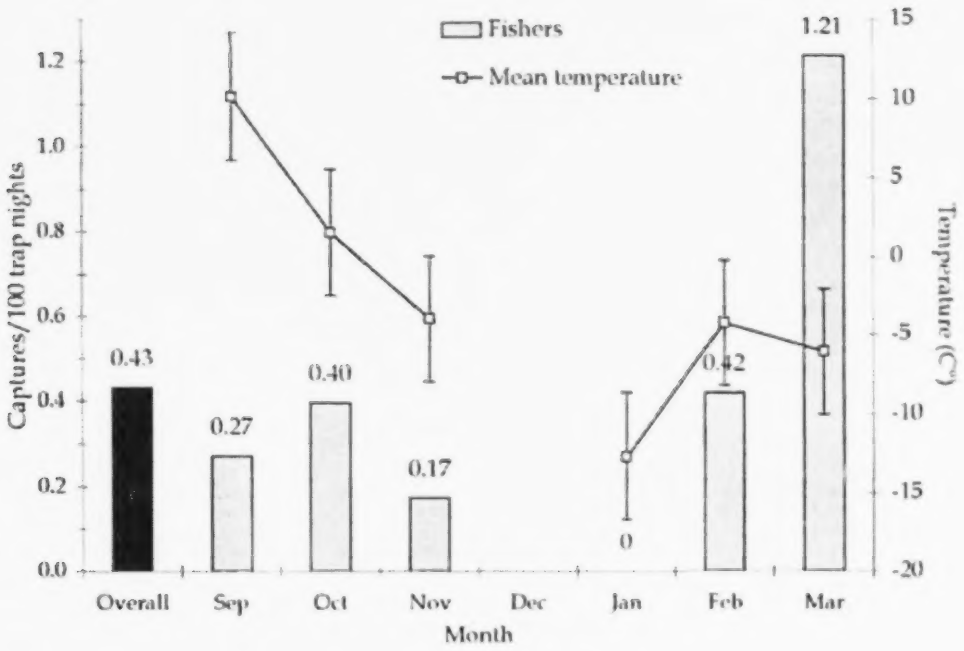

Figure 3. Capture rates of fishers and mean monthly temperatures from 4 September 1997 to 19 March 1998, Williston Fisher Inventory Project. Mean temperatures and ranges are shown for each month. No trapping was conducted during December.

Table 3. Trapping effort expended between 4 September 1997 and 19 March 1998 to recapture fishers radio-collared during 1996/97 trapping season, Williston Fisher Inventory Project.

ID	Name	Number of trap sites within home range	Number of trap nights
F01[a]	Beau	15	658.5
F02[a]	Patches	5	171.5
F03	Amelia	14	404.0
F04[a]	Cali	8	323.5
F05	Solo	12	268.5
F07[b]	Inka	7	212.5
F09	Olsie	7	136.5

a Captured and recollared.
b Captured but not recollared.

Table 4. Rate of malfunction (occurrences per 100 trap nights) by trap type during 3003.5 trap nights from 4 September 1997 to 19 March 1998, Williston Fisher Inventory Project.

	Trap type				
Malfunction type	Havahart collapsible (983.5 trap nights)	Havahart permanent (895.0 trap nights)	Log-cabin (1095 trap nights)	Barrel (30 trap nights)	Total
Blocked	1.22	1.45	2.65	0	1.80
Tripped	7.02	7.82	1.46	0	5.16
Escaped	0.10	0.34	0.37	0	0.27
No bait	2.75	0.22	3.20	0	2.13
Total	11.08	9.83	7.67	0	9.36

4.3 Immobilisations

We captured and processed 7 female and 2 male fishers (Table 5) in our study area from 23 September 1997 to 19 March 1998. In addition, on 3 March 1998, one fisher escaped from the handling cone before drugs could be administered. We caught and radio-collared a fisher (F06) at the same trap on 19 March; this was likely the same individual that was caught on 3 March.

Fishers ranged in size from 2.2 kg (F10) to 4.5 kg (F01). We administered a mean dosage of 7.8 mg/kg (SE = 1.3, n = 9) of Telazol. These dosages produced anaesthesia ranging from 20 to 55 minutes. A premolar tooth was removed for ageing purposes from 2 of the fishers (F06, F13) that were immobilised. We were unable to test for differences in morphological measurements between male and female fishers (Table 6) because of the small sample size.

4.4 Radiotelemetry Monitoring

We located 13 fishers on 235 occasions using several methods between 4 May 1997 and 19 March 1998 (Table 7). We located fishers from the air 194 times and 24 times using ground telemetry during this time. In addition to telemetry locations, we also had 12 successful captures and 5 final locations for fishers that died or shed their collars. From 18 November 1996 to 19 March 1998, the majority of locations (80%, 240 of 299) for which the time of location was recorded were collected between 09:01 and 15:00 (Figure 4). In 1997/98, we located fishers 66 times during winter, 122 times during summer, and 47 times during autumn (Table 8).

Table 5. Dates of capture and immobilisation of fishers between 23 September 1997 and 19 March 1998, Williston Fisher Inventory Project.

ID	Name	Sex	Est. age	Date trapped	Trap type
F01	Beau	M	ad	17/02/98	Havahart
F02	Patches	F	ad	16/02/98	Log-cabin
F04	Cali	F	ad	14/03/98	Log-cabin
F06	Fester	M	juv	19/03/98	Havahart
F07	Inka	F	ad	13/03/98	Log-cabin
F10	Luci	F	juv	25/10/97	Havahart
F11	Clouds	F	juv	09/11/97	Log-cabin
F13	Rose	F	juv	23/09/97	Havahart
F300	Linnea	F	ad	13/11/97	Havahart

Table 6. Morphometric measurements of female and male fishers immobilised between 23 September 1997 and 19 March 1998, Williston Fisher Inventory Project.

	Female			Male		
	Mean	± SE	*n*	Mean	± SE	*n*
Weight (kg)	2.6	0.1	7	4.1	0.5	2
Neck girth (cm)	16.1	0.3	6	19.8	1.3	2
Chest girth (cm)	21.9	0.4	7	26.5	1.5	2
Head width (cm)	5.8	0.1	6	7.5	0.4	2
Head depth (cm)	4.7	0.1	6	5.7	0.4	2
Head circumference (cm)	18.8	0.7	6	24.0	1.5	2

Table 7. Summary of locations for each fisher between 4 May 1997 and 19 March 1998, Williston Fisher Inventory Project.

ID	Name	Date first collared	Aerial telemetry	Ground telemetry	Capture/ mortality	Total locations
F01	Beau	Jan 1997	19	2	3	24
F02	Patches	Nov 1996	42	1	2	45
F03	Amelia	Feb 1997	15	11	1[a]	27
F04	Cali	Nov 1997	3	0	2[a]	5
F05	Solo	Feb 1997	23	2	0	25
F06	Fester	Mar 1998	0	0	1	1
F07	Inka	Feb 1997	32	5	1	38
F09	Olsie	Mar 1997	45	1	0	46
F10	Luci	Oct 1997	5	0	2	7
F11	Clouds	Nov 1997	2	0	2	4
F13	Rose	Sep 1997	3	0	1	4
F16	Frankie	Apr 1997	0	0	1	1
F300	Linnea	Nov 1997	5	2	1	8
Total			194	24	17	235

a Shed collar

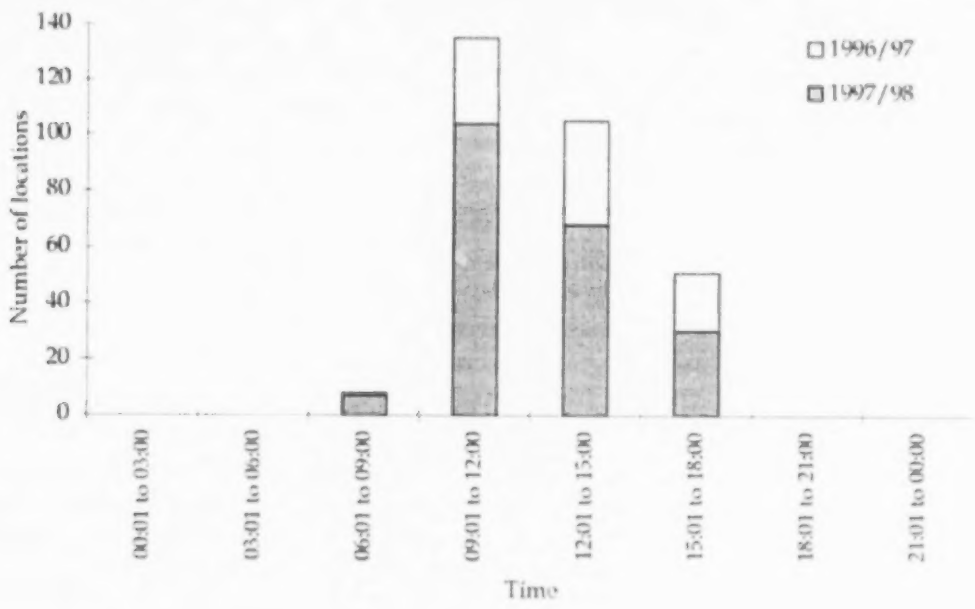

Figure 4. Distribution of location times of radio-collared fishers during ground and aerial telemetry between 18 November 1996 and 19 March 1998, Williston Fisher Inventory Project. The majority of locations were collected between 09:01 and 15:00. *n* = 299 locations.

Table 8. Frequency of location by season of radio-collared fishers between 18 November 1996 and 19 March 1998, Williston Fisher Inventory Project. Winter: 15 November to 31 March; Summer (including rearing): 1 April to 15 August; and Autumn: 16 August to 14 November.

	1996/97	1997/98	Total
Winter	56	66	122
Summer	58	122	180
Autumn	n/a	47	47
Total	114	235	349

Of the 11 transmitters that we attached to fishers during the 1996/97 trapping season, we were able to recollar only 1 fisher (F02) during the 1997/98 trapping season before either the animal shed its collar, died, or the collar malfunctioned. The webbing separated on the radiocollars of 2 fishers and the collars were subsequently shed by the animals (F04, F03). Three fishers died (F16, F30, F300), while the transmitting unit of 4 collars stopped emitting signals before we could recollar the fishers (F01, F05, F07, F08). We were unable to recapture one fisher with a functioning radiocollar (F09) during the 1997/98 trapping session.

4.5 Mortalities

We observed only one incidence of natural mortality of the 12 radio-collared fishers that we followed from 4 May 1997 to 19 March 1998. During an aerial telemetry flight on 4 May 1997, we located the collar of F16 indicating mortality. We recovered the radiocollar and carcass in a cutblock 3,820 m from the natal den that F16 had begun using by 19 April 1997. The female fisher was positioned head-down in a small hole under a patch of regenerating subalpine fir trees in a 20 year-old cutblock. The carcass was intact and covered with leaves and other ground litter. A necropsy discerned that death was caused by trauma to the occipital region of the skull (H. Schwantje, DVM, personal communication). We also discovered a moderate amount of haemorrhaging on the ventral region of the throat. Puncture holes on the dorsal and lateral portions of the occipital wounds were consistent with the spacing of the canines of a male fisher.

Three fishers were harvested in our study area during the 1997/98 trapping season by registered fur trappers (738T009, 2 fishers; 738T005, 1 fisher). Two of the fishers were animals that we radio-collared during the autumn and early winter of 1997 (FH, F300). FH was trapped in a Conibear 220 set on trapline 729T005 on 24 November 1997. F300 was trapped on trapline 738T009 between 9 and 18 December 1997.

One other radio-collared fisher died during 1997/98. F10 died between 28 November and 9 December 1997. We retrieved her carcass from under a wood pile at a guide-outfitter's camp at Pelly Lake, where we found her curled up and lying on a bed of hay. We did not locate any external wounds. A necropsy is scheduled to determine the cause of death.

4.6 Home Range and Movements

From locations collected between 18 November 1996 and 19 March 1998, we estimated annual home ranges for 7 radio-collared fishers (6 females, 1 male; Table 9, Fig. 5). Between 20 and 63 locations were used to calculate 95% MCP and adaptive kernel (90% UD) estimates of home ranges, as well as core areas (50% UD). The mean 90% UD home range size for females was smaller than that of the one male that we monitored ($\bar{x}_{female}$ = 50.6 km^2, SE = 20.7, n = 6; male = 183.9 km^2). The mean core area of the females was also smaller than that of the male ($\bar{x}_{female}$ = 9.0 km^2, SE = 1.9, n = 6; male = 52.0 km^2). Those animals with insufficient locations to perform home range analyses ranged between 10.2 km^2 and 1,237.0 km^2 (100% MCP).

At least three of the six fishers that we radio-collared during autumn 1997 were juveniles (F10, F11, F13). However, we were only able to monitor one of the juveniles (F10) frequently enough to assess dispersal movements. F10 was initially trapped near the Mesilinka River on 25 October 1997. During the time we monitored her, she moved at least 132 km, traveling at least 74 km (straight-line distance) between 2 locations in less than 8 days. The distance between her capture site and the site where she died was 77 km. We recorded her ranging over 1,237 km^2 (100% MCP). We collected only 4 locations on the remaining 2 juveniles because one was killed by a trapper (FH) and we were unable to consistently detect signals from the other fisher (F13) 4 weeks after being radio-collared.

4.7 Habitat Use

We assigned 325 locations of fishers collected between 18 November 1996 and 19 March 1998 to one of six precision categories (Table 10). In total, we collected 9 locations suitable for element scale analyses, 105 locations for patch scale analyses, 187 locations for stand scale analyses, and 325 locations for landscape (home range) scale analyses. We were unable to assign 24 locations to precision categories because the data that were collected were incomplete.

Table 9. Annual home range and core area estimates for radio-collared fishers from 18 November 1996 to 19 March 1998, Williston Fisher Inventory Project. Three fishers (F06, F08, F30) were not included because of insufficient data.

ID	Name	Sex	Number of locations[a]	Home range (km^2) MCP[b]	Home range (km^2) 90% UD[c]	Core area[d] (km^2)
F01	Beau	M	34	157.1	183.9	52.0
F02	Patches	F	63	20.4	23.4	5.1
F03	Amelia	F	41	21.3	35.1	4.7
F04	Cali	F	20	22.6	86.2	6.9
F05	Solo	F	39	42.1	60.2	14.2
F07	Inka	F	49	27.7	36.1	7.3
F09	Olsie	F	58	60.0	63.0	15.8
F10	Luci	F	8	1237.0		
FH	Clouds	F	4	56.1		
F13	Rose	F	4	12.1		
F16	Frankie	F	7	10.2		
F300	Linnea	F	8	15.6		

a includes all capture, mortality, aerial telemetry, and ground telemetry locations

b Minimum convex polygon method (95% MCP for animals with >15 locations, 100% MCP for < 15 locations)

c Utilisation distribution estimated from adaptive kernel method

d 50% utilisation distribution

Table 10. Precision of 325 locations of radio-collared fishers from 18 November 1996 to 19 March 1998, Williston Fisher Inventory Project.

Estimated precision	Error area	Scale analysis[a]	1996/97	1997/98	Total
±<1 m	none	E, P, S, L	6	3	9
± 1-30 m	< 0.3 ha	P,S,L	28	68	96
±30-50 m	0.3 - 0.8 ha	S, L	0	61	61
± 50-100 m	0.8 - 3.0 ha	S, L	0	21	21
± 100-250 m	3.0 -19.6 ha	L	57	49	106
± >250 m	> 19.6 ha	L	18	14	32

a E = element, P = patch, *S* = stand, L = landscape (home range)

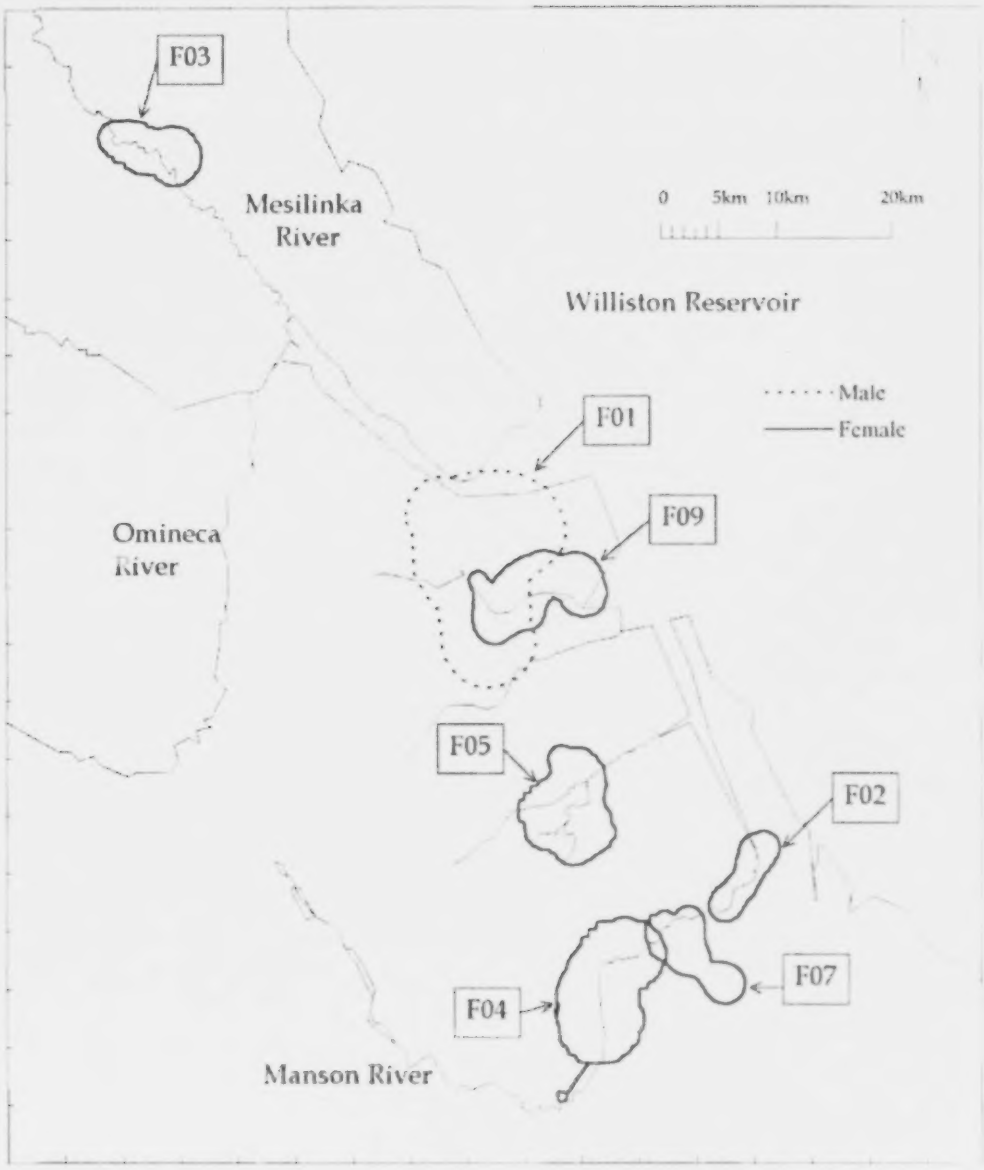

Figure 5. Annual home ranges (90% UD - adaptive kernel method) of radio-collared fishers from 18 November 1996 to 19 March 1998, Williston Fisher Inventory Project. Polygons connected with a line represent disjunct home ranges for one individual (F04). Approximate scale 1:562,000.

4.7.1 *Landscape Scale*

We determined the biogeoclimatic variant classification for 349 locations of fishers from 18 November 1996 and 19 March 1998. We located fishers primarily in the moist-cool 2 variant of the SBS (SBSmk2: 68.8%, 240 of 349 locations), but also in the SBS wet-cool 1 variant (SBSwk1: 22.1%), SBS moist-cool 1 variant (SBSmk1: 4.6%), Boreal White and Black Spruce dry-cool 1 variant (BWBSdk1: 3.4%), and Engelmann Spruce- Subalpine Fir moist-very cold 1 variant (ESSFmv1: 1.2%).

4.7.2 Stand Scale

During aerial telemetry flights, we recorded the dominant tree species of 190 stands used by radio-collared fishers from 25 November 1996 to 10 March 1998 (Fig. 6). We recorded fishers most frequently using stands that were dominated by hybrid spruce (60 of 190 locations; 31.6%) and areas regenerating from clearcuts or burns (5 - 40 years old; 30.0%). Fishers also used stands comprised primarily of lodgepole pine (20.0%), black cottonwood (7.4%), trembling aspen (3.7%), open or unclassified habitats (3.7%), other deciduous (2.1%), black spruce (1.1%), and subalpine fir (0.5%).

4.7.2 Element Scale

From ground telemetry, we recorded 6 radio-collared fishers using 9 elements between 2 April 1997 and 29 May 1997: 5 natal dens, 2 maternal dens, and 2 resting sites.

All natal and maternal dens selected by female fishers were in large diameter, declining black cottonwood or balsam poplar *(Populus balsamifera* ssp. *balsamifera)* trees (Table 11). The mean diameter of the black cottonwood trees ($\bar{x}$ dbh = 107.0 cm, SE = 7.2, n = 6) was larger than the one balsam poplar tree (dbh = 63.5 cm). All of the dens were in cavities in the heartwood of the main bole between 5 and 16 m above ground level ($\bar{x}$ = 13.5 m, SE = 2.5, n = 6). All of the entrances to the cavities were through holes and cracks resulting from large branches breaking away from the bole. The mean date at which we recorded female fishers beginning to use natal dens was 8 April 1997 (range: 2 April - 17 April).

We climbed den trees and measured the characteristics of 3 of the natal dens and both of the maternal dens. The mean diameter at den height was 65.2 cm (SE = 2.5, n = 6). The mean aspect of the entrances to the dens was 157° and was significantly different from random (Rayleigh's z = 3.13, n = 5, P < 0.05). The mean dimensions of the den entrances

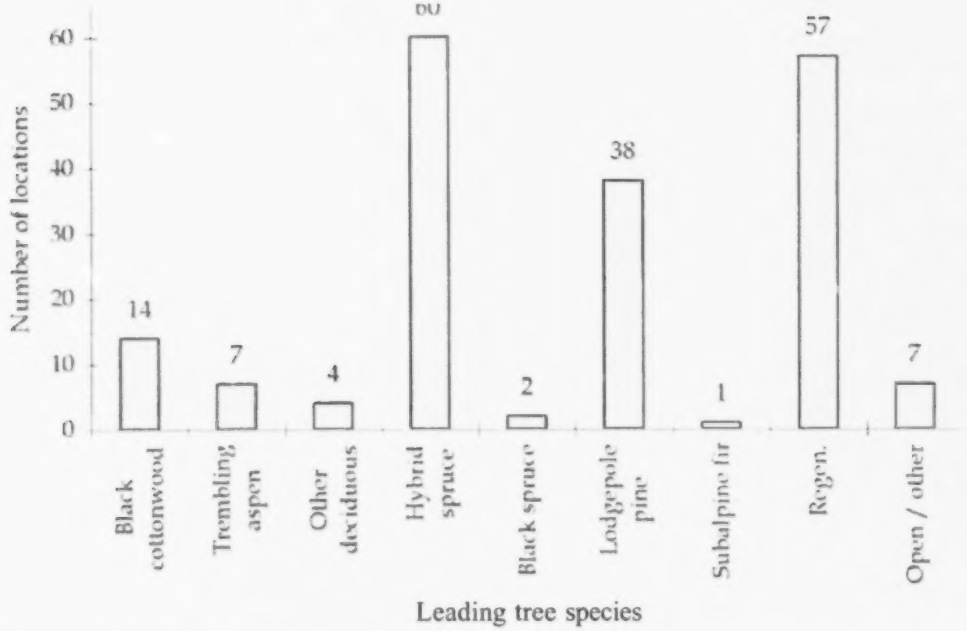

Figure 6. Leading tree species of stands used by radio-collared fishers, as recorded on aerial telemetry flights from 25 November 1996 to 10 March 1998, Williston Fisher Inventory Project. Regenerating stands (5 - 30 year old clearcuts or burns) are labelled as "Regen." *n* = 190 locations.

Table 11. Characteristics of natal and maternal dens used by radio-collared female fishers between 2 April 1997 and 29 May 1997, Williston Fisher Inventory Project.

ID	Name	Date first confirmed	Use[a]	Tree species[b]	DBH (cm)	DDH[c] (cm)	Den height (m)	Entrance height (cm)	Entrance width (cm)	Chamber height (cm)	Chamber width (cm)	Chamber depth (cm)	Aspect n
F03	Amelia	16/04/97	N	Ac	105.2								
F04	Cali	04/04/97	N	*Ac*	97.0		5						
F07	Inka	02/04/97	N	Ac	105.0	67.4	10	7	8	203	38	38	110
F09	Olsie	03/04/97	N	Ac	113.0	69.5	16	10	13	190	20	20	135
F16	Frankie	19/04/97	N	Ab	63.5	56.3	10	100	6	210	32	32	195
F03	Amelia	23/05/97	M	Ac	137.0	79.0	20	20	19	10	40	20	140
F07		29/05/97	M	Ac	84.5	54.0	20	13	10	335	10	30	210

a N = natal, M = maternal
b Ab = balsam poplar, Ac = black cottonwood
c diameter at den height

were 29 cm in height (SE = 18, n = 5) and 11 cm in width (SE = 2, n = 5). The mean dimensions of the den chambers were 28 cm in width (SE = 6, n = 5), 28 cm in depth (SE = 4, n = 5), and 190 cm in height (SE = 52, n = 5). The bottom of the chamber was not always used as the bed; at 2 of the dens, females appeared to have placed the kits on platforms within the cavity.

We located fishers using resting sites on 4 April and 21 May 1997. On both occasions, we observed fishers resting on growths caused by spruce broom rust *(Chrysomyxa arctostaphyli)* in hybrid spruce trees.

4.8 Reproduction

During our investigations of the natal and maternal dens on 15 and 16 June 1997, we did not find any sign of active use of the den trees. However, we did find the possible remains of one kit at the den of F16 (she died between 24 April and 4 May 1997). We were unable to determine the cause of death of the kit due to its advanced state of decay, but suspect that it died of dehydration.

We attempted to monitor the attentiveness of 2 females to their kits during April 1997. We monitored F09 for 10 hours with ground telemetry on 21 April. We arrived near F09's den at 09:30, at which point she was in her den. She left her den at 09:45 and did not return by 18:30. We did not locate her using this den again. We stayed at least 500 m from the den during the entire monitoring session, so it is unlikely that we caused her to abandon her den. We also monitored F03 by positioning a datalogging telemetry receiver near her natal den on 24 April. However, the recording station was disturbed by a bear and we were unable to retrieve the data.

We recorded 2 females switching from natal to maternal dens. F07 began using a maternal den by 29 May, 57 days after we first recorded her using a natal den. F03 began using a maternal den by 23 May, 37 days after we first located her using a natal den.

5.0 DISCUSSION

5.1 Capture Success

The capture rate of 0.43 fishers per 100 trap nights that we documented during 1997/98 was slightly lower than 1996/97 and most other live-trapping programmes (Table 12). The capture rate that we observed in 1997/98 was likely influenced by several factors, such as population declines, avoidance of the traps by fishers, and weather and seasonal influences. The most likely cause of the reduced capture rate that we

Table 12. Comparison of capture rates of fishers reported from studies conducted across North America.

Geographic area	Captures per 100 trap nights	Reference
Manitoba	0.10	Raine 1981
British Columbia - Cariboo	0.40	Weir, unpubl. data
British Columbia - Williston	0.43	this study, 1997/98
British Columbia - Williston	0.58	this study, 1996/97 (Weir 1997)
Minnesota	0.88	Roy 1991
Maine	1.07	Arthur 1987
Northern California	1.20	Zielinski *et al.* 1994
Wisconsin	1.59	Johnson 1984
NorthernCalifornia	2.70	Buck *et al.* 1983

observed in 1997/98 compared to 1996/97 was a potential decline in the fisher population of the study area. At least 8 fishers were killed by fur trappers in our study area over the past 2 trapping seasons. The changes in capture rate within the 1997/98 trapping season was most likely caused by changes in weather and behaviour of the fishers throughout the winter.

5.2 Trap Efficacy

The rate of trap malfunctions that we observed during the 1997/98 trapping season was less than that which occurred in the 1996/97 trapping season. We attributed the decrease in the frequency of trap malfunctions to greater attentiveness when monitoring traps, a stricter trap monitoring regime, and the use of waterproof cardboard boxes to cover the traps and petroleum jelly for lubricating the trap mechanisms. During 1997/98, we were much more diligent about ensuring that the traps were fully functional when we monitored them. We ensured that the triggers on all traps were working properly and were fully lubricated before the trap was set out and at least every week thereafter. Covering the Havahart traps with waterproof cardboard kept the inside of the traps free from snow and moisture, so fewer trap nights were lost to frozen pans and trigger mechanisms. Collapsible Havahart traps likely malfunctioned more frequently than expected because this design has more moveable parts upon which snow and ice can accumulate (i.e., solid door, locking latch).

The number of trap nights lost as a result of tripped traps increased in the 1997/98 season. This is primarily because of a longer trapping season, which began in autumn, as opposed to the winter of 1996/97.

During September and October 1997, we noted that bears frequently disturbed the traps, causing them to be tripped. During winter, ermines tripped the trigger and escaped out the side of the trap. Aside from these two sources, very few traps were tripped by other animals.

5.3 Mortalities

Two radio-collared fishers (FH, F300) died in Conibear traps which were set by trappers. These mortalities may be avoided in the future if trappers agree to use boxes for their marten traps which will capture martens, but exclude fishers. The design for the boxes would be the same as is currently used by trappers, but with the addition of a plate on the front with a hole that martens can crawl through, but fishers cannot. The diameter of the hole should be no larger than the lower 95% confidence interval of the width of the zygomatic arch of female fishers.

The death of the female (F16) that we recorded in May appears to have occurred during copulation. The back of F16's skull was probably crushed by a male while mating between 5 and 15 days after whelping. Male fishers grasp females by the back of the neck during copulation (Powell 1982), occasionally inflicting serious injuries to the female. Deaths that occur during mating are rare, but have been recorded elsewhere in British Columbia (R.D. Weir, unpublished data). It is unlikely that the death was the result of a predatory attack because the carcass was covered with debris and not consumed in any manner.

5.4 Immobilisations and Marking

We attempted to change several protocols for immobilisations from the 1996/97 trapping season. We reduced the dosages of Telazol that we administered to the fishers from 10 mg/kg to 8 mg/kg. This reduced the duration of anaesthesia slightly, but did not seem to stop the dramatic decreases (2.5-4 C°) in body temperature during anaesthesia, despite ambient temperatures ranging from -10 C° to 15 C°. We also used hot-water bottles as heat sources during several immobilisations, but this did not appear to help the fishers maintain a constant body temperature.

We tried altering the dosage that we administered to the fishers to determine if the dosage affected body temperature. In late February, we lightly anaesthetised 2 fishers with 5.5 mg/kg Telazol because we were only replacing radiocollars and a deep plane of anaesthesia was not required. This dosage induced anaesthesia for 20-25 min, during which the body temperature dropped only 1-1.5 C°. However, the fishers did not enter a plane of anaesthesia that was deep enough to perform more painful procedures such as tooth extraction.

We were able to assess the superficial effects of radiocollars on 5 fishers. All 5 fishers were radio-collared during 1996/97 and were recaptured during February and March 1998. Four of the 5 fishers were in good physical condition, with no evidence of any damage to the fur by the radiocollar. One fisher (F07) had developed localized inflammation around the radiocollar, causing the collar to become partially embedded in the skin around the neck. The skin tissue immediately under the collar had necrotised. We removed the radiocollar and the necrotic tissue from the neck, administered a broad spectrum antibiotic, and released the fisher following the immobilisation. We did not attach a radiocollar to this fisher. With the removal of the radiocollar, this injury would heal within 1-2 weeks (M. McAdie, DVM, personal communication). The rot-away firehose spacers in the radiocollars that were used during 1997/98 will decrease the likelihood of this type of damage occurring in the future.

5.4 Radiotelemetry Monitoring

During 1997/98, we experienced continuing difficulties monitoring fishers that were radio-collared with Holohil collars. However, once we were reasonably confident of the normal home range of each fisher, we consistently located the fishers during aerial telemetry flights, although we often did not detect the signal more than 2 km from its source.

We also encountered many problems successfully locating fishers from the ground that were collared with Holohil radiocollars. We were able to consistently locate only F03 and F300 because they lived in steep valleys that afforded us with many opportunities for relatively true transmission from the transmitter to the antenna. Both of these fishers lived in the Mesilinka River valley, which has many roads up and along the hillsides. Vegetation and topography diminished the distance over which signals could be detected from fishers that lived on flat plateaus or in hummocky terrain. We were often unable to detect signals of fishers that lived in these areas, even after intensively searching their home ranges.

As of 25 October 1997, we began using Telonics radiocollars with more powerful transmitters. Unfortunately, of the 7 new transmitters that we put out, 3 of the animals died (2 kill-trapped, 1 unknown cause). We seemed to have greater success locating the fishers with these new transmitters via ground telemetry compared to the previous design. We were also able to detect signals from the Telonics radiocollars from up to 15 km away during aerial telemetry flights.

We collected the majority of the locations of radio-collared fishers between 09:01 and 15:00. Thus, the data may be biased, especially for habitat use analyses, because fishers use different habitats and portions

of their home range at different times of the day (R.D. Weir, unpublished data). A concerted effort should therefore be made for future radiotelemetry monitoring to be performed throughout the day and night, so that the data that is collected is not potentially biased.

5.5 Home Range and Movements

The annual home ranges of the fishers in this study appear to be larger than those reported elsewhere in British Columbia. The mean annual home range size of female fishers in south-central British Columbia was reported to be 26.4 km^2 (Weir 1995), while the size of the home ranges of females in our study was roughly double that size (50.6 km^2). The one male fisher that we monitored had a home range (183.9 km^2) that was approximately 75% larger than the largest male home range reported by Weir (1995).

The reasons for the differences in size of home ranges between our study and that of Weir (1995) are unclear. The resources that fishers require may be distributed more sparsely in our study area, so fishers may need to cover larger areas to sequester enough resources to survive. Also, locations for some of the fishers in our study were not collected throughout the entire year, so the 90% UD estimate may be seasonally biased. Weir (1995) noted that home range size was largest during summer. Thus, our calculations of annual home range may be somewhat biased because most of our locations of fishers were obtained during the summer. More intensive monitoring in subsequent seasons will allow us to estimate seasonal home ranges and examine the effect of season on home range size.

The home ranges of the fishers in this study appear to follow the intrasexually exclusive spacing pattern that is common among members of the genus *Martes* (see Powell 1994, Weir 1995). We observed very little overlap of annual home ranges among female fishers, but extensive overlap between the home ranges of F01 (male) and F09 (female). The only overlap of female home ranges that we observed occurred on the Manson River, between F04 and F07. The respective locations that contributed to this spatial overlap occurred at very different times and may be the result of temporal avoidance (Weir 1995).

We were unable to document many examples of juvenile dispersal because of difficulties collaring juveniles and low juvenile survivorship. We did, however, follow F10 for 2 months. F10 was exhibiting signs of site fidelity before she died, which suggests that she had located a suitable area in which to establish a home range. She covered over 1200 km^2, travelled at least 132 km, and died 77 km from where she was captured during the 2 months that she was transient.

The distances and area over which F10 travelled while she was transient were large compared to transient fishers reported elsewhere in the literature. Weir (1995) reported that 2 translocated fishers in south-central British Columbia ranged over at least 900 km^2 while transient. As noted by Weir (1995), large rivers and elevational changes were not barriers to movement; during her transient period, F10 crossed over both the Mesilinka and Ingenika Rivers. The farthest that female fishers in Maine dispersed was 22.6 km from their natal territories (Arthur *et al.* 1993), which was substantially less than the net dispersal distance exhibited by F10. More work should be directed to examining the factors affecting dispersal patterns of juvenile fishers.

5.6 Habitat Use

5.6.1 Landscape Scale

Fishers in our study area used the SBSmk2 biogeoclimatic variant more frequently than other variants. This result was not unexpected; we trapped primarily in the SBSmk2 and the home ranges of 6 of the 13 fishers that we monitored were comprised almost entirely of this variant. Conclusions regarding landscape selection by fishers should only be drawn upon the completion of use versus availability analyses comparing the composition of the home range to that of the landscape.

Juvenile fishers primarily used the SBSmk2 variant while transient, but also used other biogeoclimatic zones, including the ESSFmvl. The ESSFmvl is a high-elevation variant which is thought to have low capability for supporting fisher populations and consists of habitats that are infrequently occupied by fishers. Our observation of transient fishers using "sub-optimal" habitats is consistent with the findings of Weir (1995), who reported that fishers use more variable habitats while transient. Future work needs to be directed towards determining the effects of landscape composition on the dispersal patterns of juvenile fishers.

5.6.2 *Stand Scale*

As recorded during aerial telemetry flights, the frequent use of hybrid spruce stands as well as regenerating clearcuts or burns is not unexpected. Both of these stand types comprise substantial proportions of our study area and use of these stand types may not constitute any preference by fishers for these stand types. Conclusions regarding habitat selectivity should only be drawn after the appropriate use versus availability analyses have been performed. Habitat data needs to be collected so that we may accurately evaluate habitat selection at

each spatial scale. Future effort needs to be directed towards habitat sampling so that habitat selectivity by fishers can be examined.

5.6.3 *Element Scale*

We examined 5 natal and 2 maternal dens during 1997/98, all of which were located in large diameter, declining black cottonwood or balsam poplar trees. Unlike eastern studies, where fishers whelp in smaller diameter trees ($\bar{x}$ = 45 cm, Paragi 1990; $\bar{x}$ = 66 cm, Powell *et al.* 1997), fishers in our study seemed to use atypically large trees in which to whelp. These types of trees appear to have distinctive characteristics that make them suitable for denning (Weir 1995).

All of the dens consisted of holes through the hard outer sapwood into cavities in the inner heartwood. Black cottonwood trees are prone to decay of the heartwood at an early age (Maini 1968), but appear to form cavities sufficient for rearing by fishers only when the bole is greater than 54 cm diameter. For the cavity to be used by fishers, it also appears that the cavity entrance needs to be greater than 5 m above ground. Elements with all of these traits may be rare across the landscape of the SBS biogeoclimatic zone and may be an important component in the selection of home ranges by female fishers (Weir 1995). Future work needs to determine the frequency with which these features occur and the effects of the distribution of these elements on female fishers.

The aspects of the den openings were significantly different from random with the mean aspect south-east, which likely conferred some thermal advantages to the female and her kits. Although Powell *et al.* (1997) did not find that female fishers in central New England selected den openings with any specific aspect, Paragi (1990) found that the mean aspect of natal dens in Maine was to the south. The southern aspect, in addition to the height of the cavity, likely maximises the amount of solar radiation that is intercepted by the bole of the tree at the den (Leonard 1980). Powell *et al.* (1997) noted that the height of successive maternal dens decreased, which they attributed to the decreasing need for warmer microclimates as the overall temperature increased in May. Since we located natal and maternal dens during April, our data supports the hypothesis that fishers select dens that offer a favourable microclimate (i.e., high above ground, facing the sun). Future effort needs to be directed towards determining if the aspect of maternal dens (i.e., those used after the natal den) favours the south.

We also located 2 resting sites, both in hybrid spruce trees infested with spruce broom rust. Spruce broom rust typically forms flat-topped clumps of dense growth (brooms) upon which fishers can rest. We

recorded fishers using these resting sites when the ambient temperatures were 2 C° and 10 C°. This result is consistent with that of Weir (1995), who reported that fishers rested primarily on rust brooms when temperatures were above -20 C°. Arthur (1987) and Jones (1991) also reported fishers using tree nests during spring and autumn, when temperatures are moderate (i.e., above -5 C°). We need to identify more resting sites at a variety of temperatures to determine the temperature-specific requirements for resting habitats for fishers, as well as examine the distribution of resting sites.

5.7 Reproduction

The patterns of whelping that we observed were broadly compatible with results reported elsewhere. We recorded 5 female fishers using natal dens at the beginning of April 1997. The mean whelping date of the 5 females with kits was 8 April, which was not substantially different from that reported by Weir (1995) in south-central British Columbia (10 April). However, in eastern portions of its range, fishers whelp much earlier (4 March - 24 March, Powell *et al.* 1997). This difference in whelping dates is likely because of climatic differences between the two regions.

Female fishers in this study also changed dens as the rearing season progressed. Although we located only 2 maternal (i.e., post-natal) dens, we observed that each of the females abandoned their natal den after 5 to 8 weeks of use. This period of use of the natal den was longer than that reported by Powell *et al.* (1997) in New England and Paragi (1990) in Maine, who each noted that female fishers used 1-5 dens over a 6-8 week period while rearing their kits. Elsewhere in British Columbia, female fishers changed dens after 2-3 weeks of occupancy (R.D. Weir, unpublished data). We may not have located subsequent dens for 2 of the 5 females because of the decreased time that females spend at later dens. We should intensively monitor females with kits for the entire rearing season to locate all maternal dens that are used following parturition.

We were not able to tag any of the kits that may have been born to the five female fishers that whelped during the spring. We likely arrived at the maternal dens after the females had either abandoned the dens or had begun using temporary dens (Powell *et al.* 1997). Also, the females may have moved to other maternal dens and we were unable to identify these structures because we located the fishers during the day only. By mid June, the females may return to the maternal den at night only (Paragi 1990); thus, we would not have been able to detect them during our daytime telemetry locations. Future effort should be

directed towards telemetry at night during May so that we can locate the subsequent maternal dens and monitor den attentiveness.

6.0 CONCLUSIONS

We met several of the objectives of the monitoring phase of the project by following 11 radio-collared fishers during the 1997/98 year. We collared 5 new fishers, as well as recollared 3 fishers from the first year of the study. We estimated annual home ranges for 7 fishers and monitored the movements of 3 juveniles. We located natal dens for 5 female fishers and documented the use of 2 maternal dens. However, we were unable to assess the productivity of these females. We recorded female fishers rearing their young exclusively in large diameter, declining black cottonwood or balsam poplar trees. We also recorded fishers most frequently using stands dominated by hybrid spruce and regenerating stands.

7.0 RECOMMENDATIONS

7.1 Trapping

- Trap intensively for fishers between February and March. Biotic, abiotic, and behavioural factors during this period likely increase the likelihood of captures.
- Trap for juveniles during an intense 3 week period in October. Fewer trap nights will be lost to bears disturbing the traps during this time.
- Continue to cover Havahart traps with waterproof cardboard and line with straw.
- Place a Havahart trap at each log-cabin trap to reduce the number of trap nights lost to non-target species.
- Place jam in traps to act as a source of sugar for animals. This should reduce the possibility of trapped animals developing hypoglycaemia and incidental mortality.
- To recapture known animals, attempt to concentrate trapping effort to single home ranges for 2-3 week periods to increase the likelihood of fishers encountering traps.

7.2 Immobilisation and Handling Procedures

- Use Telazol at 8 mg/kg for all future immobilisations that require painful procedures, 5 mg/kg for short, painless

procedures (e.g., collar replacement). Record dosage, duration of anaesthesia, body temperature, and cardiac and respiration rate at regular (e.g., 10 min) intervals throughout the procedure.

- Continue to tattoo the inguinal region with an identification number.
- Continue to use rot-away firehose spacers in radiocollars.

7.3 Radiotelemetry

- Continue to use Telonics radiocollars.
- Monitor radio-collared fishers throughout the day and night to assure unbiased data.
- Allocate effort to locating resting sites at various temperatures and times of day.
- Examine factors affecting juvenile dispersal patterns of juvenile fishers by conducting intensive monitoring (e.g., 2-3 times per week). Attempts should be made to tag fishers while in their natal territories, perhaps during intensive trapping during October (see Arthur *et al.* 1993).
- Identify and monitor radio-collared females at natal and maternal dens (e.g., monitor den attentiveness).
- Conduct intensive monitoring to estimate seasonal home ranges and determine the effect of season on home range size.
- Intensively monitor females with kits for the entire rearing season (April - June) to locate all maternal dens that were used following parturition. Future effort should be directed towards telemetry at night during May so that we can locate subsequent maternal dens and monitor den attentiveness.

7.4 Habitat

- Perform habitat assessments for locations that have the appropriate degree of precision. Use photo-interpretation techniques to identify the stand type used by fishers. Perform vegetation sampling to ground truth photo-interpreted sites and assess patch level use by fishers.
- Assess the availability of habitat at each spatial scale so that use versus availability comparisons can be performed.
- Continue to identify and measure elements used by fishers for whelping and rearing.

- Collect data to examine the frequency with which black cottonwoods and other identified structures form cavities suitable for denning.
- Identify resting sites at a variety of temperatures to determine the temperature-specific requirements for resting habitats for fishers.

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9.0 APPENDIX

9.1 Appendix 1: Chemical Immobilisation Form

Chemical Immobilisation Forni

ID: _____ Collar Freq.: _____

Date (ddmmyy): _____ Trapsite: _____

Trap (circle): Cage Log-cabin UTM: _____

Recorders: _____ Time trap set (hrs): _____

Eartags (colour and # of tag): L: _____ R: _____

New/Recapture (circle one) Tattoo Location: _____

Hair sample location: _____

Blood sample taken: Yes No Vein: _____

Drug Type	Volume (ml)	Time of Injection	Injection Site
Down Time:		Up Time:	

Time	Body Temp	Respiration Rate (bpm)	Heart Rate (bpm)	CRT

Appendix 1 (cont.)

Sex (circle one): Female Male Weight (kg): _____

Neck girth (cm): _____ Chest girth (cm): _____

Body length (cm): _____ Tail length (cm): _____

Head width (cm): _____ Head depth (cm): _____

Head circumference (cm): _____

Teeth condition: _____

Tooth removed (circle): PM1 None Other _____

Reproductive status (circle one): Inactive Pre-breeding Active

Photographs (circle as applicable): Roll: _____ Photos: _____

Head-front Head-side Body-side Body-ventral

General comments: _____

9.2 Appendix 2: Aerial Telemetry Form

Date (ddmmyy): Pilot:

Observer: Navigator:

Species: Coordinates (specify NAD27 or NAD84)

Frequency: Latitude:

Animal ID: Longitude:

Time of location: Easting:

Northing:

Habitat type: (Forest Cover/Site Series)

Canopy cover (%):

Elevation: (specify ft / m)

Aspect: N NE E SE S SW W NW

Meso Slope: Flat Shallow Moderate Steep

Macro Position: Apex Face Upper Middle Lower Valley Floor Flood plain

Photos: Roll #: Photo #:

Comments:

Diagram:

Scale: (m) Precision: ±

PLOTTING

Map sheet #

Airphoto #

Flight line:

Plotted coordinates:

Geographic datum
(circle one)
NAD27 NAD84

Easting Northing

Comments:

9.3 Appendix 3: Ground Telemetry Form

GROUND TELEMETRY DATA FORM

Date (ddmmyy):	Surveyor:
Animal name:	Animal ID:

	Station name	Stn#	Brng	Time	Signal[a]	Bias[b]
1						
2						
3						
4						
5						
6						
7						
8						
9						

a C = constant P = pulsing F = faint Blank = indeterminate

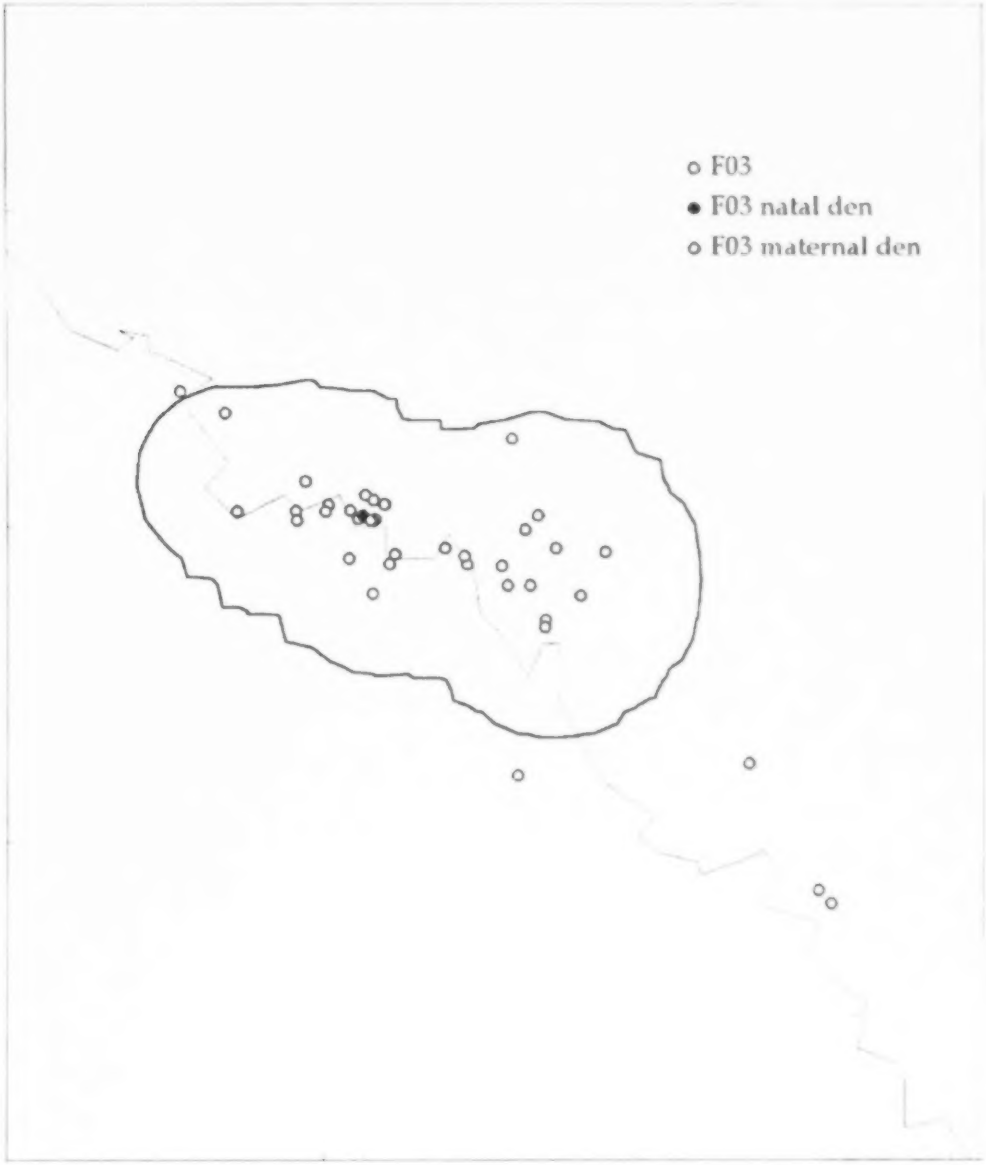
b V = vegetation T = topography B = both veg. and topo. Blank = no bias

Notes: _____

9.4 Appendix 4: Home range polygons and locations of fishers

9.4.1 Home ranges (90% UD) and locations of F01 and F09 from 4 January 1997 to 16 March 1998, Williston Fisher Inventory Project. Dashed line represents male home range; solid line represents female home range. Approximate scale 1:135,000.

9.4.2 Home range (90% UD) and locations of F03 from 24 February to 14 August 1997, Williston Fisher Inventory Project. Approximate scale 1:102,700.



9.4.3 Home ranges (90% UD) and locations of F02, F04, F05, and F07 from 18 November 1996 to 14 March 1998, Williston Fisher Inventory Project. Polygons joined by a line represent disjunct home ranges for an individual animal. Approximate scale 1:194,000.